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Outline.

- Gas turbine power generation.
- Technology status and challenges.
- Current R&D.
- Future Research Needs.
- UK Capabilities and opportunities.
- Conclusions.
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Alstom GT26.

- Ni-base alloy/ MCrAlY / TBC
- Ferritic Steel
- Austenitic Steel
- SX Alloy / MCrAlY / TBC
- DS Alloy / MCrAlY
- Rotor ferritic steel
- Ni-base Alloy / Chromizing

- 360 single crystal components
- 86 DS components
- over 1000 precision cast parts
Siemens SGT5-8000H.
Samarinda, Indonesia.

60MW combined cycle installation © Rolls-Royce plc

- Power Station.
- House and Factory.
- Transport.
- Compressor Stations.
- Oil Refinery.
- Pipeline.
- Gas.
- Oil.

Energy Materials GT
Energy Conversion.

% efficiency

- Transport
- Industrial diesels
- Coal fired power station
- Gas turbine
- Combined cycle gas turbine
- Fuel cells
- Combined heat & power

Energy Materials GT
World Demand – 10 Years From 2007.

- Estimated to be $137bn.
- Demand traditionally driven by US and Europe.
- Rest of the World increasingly important. driven by China, India, Russia and Latin America.

Source: Forecast International 2007
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Key Areas.

- Compressors.
  - Fe and Ti based alloys.
- Combustors.
  - Wrought Ni sheet.
- Turbines.
  - Blades.
    - Cast or wrought Ni-alloys.
  - Discs.
    - Wrought Ni-alloys.
- Steel rotors.
- Sealing.
- Coatings.
- Repair.
Issues and Limitations 1.

- Increased Temperature.

- Driven by need for efficiency and low emissions.
- In all areas current materials are operating at or beyond their limits.
- Coatings increasingly used as a short/medium term solution.
- Urgent need to increase temperature capability at extended lives and at an affordable cost.
- Material distress, damage, unscheduled repair and replacement.
Issues and Limitations 2.

- Oxidation/Corrosion.
  - Becoming a bigger issue. Corrosion appearing more widely throughout the engine and in areas it is not expected in – not understood.
  - Oxidation limiting high temperature performance in hot areas – unable to predict lives reliably.
  - Early failures and unplanned repair/maintenance.
Issues and Limitations 3.

- Whole life costs.

- Biggest challenge for existing and new materials.
- Raw materials costs increasing rapidly (e.g. CMSX4 – Re $9,500/kg).
- Cost effective manufacturing (net net shape).
- Repair and re-use.
- Disposal.
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Current R&D Trends.

- Concentrating on incremental development of existing materials and coatings.
- Very dependant on aero derived technology in many areas leading to issues of affordability and suitability.
- Tends to be based on OEMs and specific to individual companies – little collaboration.
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Future Needs - General.

- Urgent need to validate existing new alloys at real scale – over dependence on unvalidated models and lab/small scale experiments.
- Integration of all aspects needed to deliver a systems solution (materials, coating, NDE, lifeing, joining and repair).
- Increasing focus on extending existing power plant lives (e.g. Supergen 2).
5 Years.

- Integrated development of existing classes of materials
  - Materials for increased life/temperature capability at appropriate scale.
  - Coating technology that can be applied to above to address oxidation/corrosion and erosion issues and increase temperature capability.
- Development of effective repair and refurbishment for existing plant and materials.
- Advanced joining technology (including bolts).
- Robust sealing technology.
- Increased collaboration (OEM, end users, academia supply chain) – especially on low TRL issues.
10 Years.

- Development of new material systems solutions based on existing knowledge including behaviour in realistic environments.
- Development and application of process modelling to new materials to speed up introduction and help define new system solutions.
- Adopting a total system approach to critical part design and life prediction with multi-material components with joints and coatings.
Development of novel, step change, material systems that will enable high overall efficiencies that will significantly reduce emissions.

- Not based on existing technology.
- Will require radical thinking about manufacturing and processing.
- Opportunity to avoid traditional high cost strategic materials.

Needs to be launched now to deliver in time.
Gas turbine power generation.

Technology status and challenges.

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Conclusions
UK Capabilities and Opportunities.

**Strengths.**
- Strong academic network for materials development and understanding in all areas.
- Large OEMs active in R&D and who are capable of driving research agenda.
- Support from funding agencies to help make it happen.

**Weakness**
- Supply chain is largely offshore.
- Lack of long term funding strategy.
- Unfashionable materials.
- Lack of consistent policy.
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Conclusions.

- UK has the capability, skills and resources needed to meet the materials challenge.

- Urgently need to launch a coherent suite of programmes for the 5 and 10 year needs.
  - Needs strategy and long term stable funding sources, 3 years funding for programmes will not work.

- Strategy for materials development to meet the 20 year need needs to be defined and launched (NOT pick a winner and hope) to enable low TRL work to be completed in time.